THE SCIENTIFIC WORK OF THE SAN DIEGO MARINE BIOLOGICAL STATION DURING THE YEAR 1908

THIS year puts the Marine Biological Station of San Diego farther forward on the road to its ideals than has any single year of its previous existence. This results primarily from the circumstances that this year a new boat, the *Alexander Agassiz,* ample for the operations at sea, has gone into commission, and that more funds than hitherto have been available for running expenses.

"A comprehensive biological survey of the waters off the coast of southern California" has been announced from the outset as the station's scientific program. Such an expression of aims is surely somewhat vague; it might be looked upon as somewhat visionary or grandiose, and at least impracticable if any definite meaning be attached to the word comprehensive. Since it is now affirmed that real progress is being made toward realizing the aims, it ought to be possible to show wherein these aims are not wholly vague, are not in spirit grandiose, and are within limits of practicability.

On the theoretical side all, or at any rate much, does indeed hinge on the meaning of "comprehensive" as used in the preamble. It expresses an attitude or standpoint relative to biological research generally, rather than a determination to study every creature exhaustively regardless of rhyme or reason, that may happen to enter or may have a permanent home in these waters. What that attitude is may be stated thus: *To know, to understand organic beings is the object of biology. No phenomenon essential to the life-career of any organism can be pronounced as fully explained so long as any other phenomenon likewise essential to that same life-career is entirely unknown or entirely ignored.* Such is the conceptual matrix in which is set every plan made, every dollar expended, every day's work done, every page printed, at least so far as the scientific director is concerned, in connection with the San Diego Station.

Even allowing the conception to be right, does not the proposal to embody it in an institution of research mean certain failure from the simple fact that it runs counter to the principle of specialization, the principle which has been the king-pin of progress in all recent science? On the face of the matter it looks that way. In truth, though, violence to the principle is neither intended nor done. Quite to the contrary, specialization even more refined and intense than ever, is compelled at some points. The only unusual thing is that the program calls for specialization *in more directions* than is customary for one and the same institution; and that it gives this specialization *organic coordination* in greater measure than biological research has usually had.[1]

[1] On no account would I have the statement of aims of the San Diego Station seem to be oblivious of the similar work being prosecuted in various other parts of the world, especially in European seas. Our obligations to the International Council for the Investigation of the North European Seas, to the Prince of Monaco's extensive oceanographic enterprises, and to the Port Erin Station must be specially acknowledged.

Perhaps no better evidence can be adduced of our sensibility of dependence upon these agencies than by mentioning that Professor C. A. Kofoid, assistant director of the San Diego Station, who is spending his sabbatical year in Europe, is being paid a portion of his expenses by the station to enable him to see as much as possible of what these great enterprises are doing. It is our purpose to adopt the methods and apparatus used by the International Commission as far as may be.

The uniqueness of our program, if it has any, lies in the circumstance that being primarily biological rather than oceanographic, and being in its inception independent of any specified industrial motive, it can concentrate everything on whatever biological problems seem most inviting, most urgent or most accessible at any given time.

To make these generalities concrete, take the group of closely related, really inseparable problems comprised under the term distribution. I set for myself the task of finding what species of salpa occur in the area of the Pacific marked off for study. After some years of collecting I find a total of say eight species. By the time my studies have been extensive enough to make me nearly certain that no others are to be found, I have become keenly aware that some of these eight are much more abundant than others. Moreover, by watching the tow-net hauls as they come in from day to day and from week to week, and by running back over my records for some years, I make out, approximately at least, the order of abundance of the different species for the area. *S. fusiformis-runcinata* clearly heads the list, *S. democratica-mucronata* comes next, then probably, though not quite certainly, *Cyclosalpa affinis,* and so on. Again, my observations having reached over so long a period and over so much material, I could not fail to recognize certain rules according to which some at least of the species, *i. e.,* the more abundant ones, are distributed through the year and through the different depths of water. Intimations are found too of rules prevailing in the reproductive activity of the commoner species for both the sexual and the asexual phases of the life cycle. It seems that the different species reach their maximum abundance at different times of the year; that one species probably occurs at greater depths than another ever does; that the climax of abundance is brief for one species while more extended for another, and so on.

Were I willing to stop with commonplaces of zoology such as these, nothing would be required for my pursuits beyond efficient means of collecting (which in this case happen to involve considerable expenditure), some diligence in getting together, examining and recording material, and a little acumen in seeing and question-asking. But surely the knowledge thus gained is far from *full knowledge* of these particular animals. How comes it that *S. fusiformis-runcinata* is the most abundant species in these waters, while *S. cylindrica* turns up as hardly more than a straggler? Why, as has been the case this summer at least, does *S. democratica-mucronata* swarm in early June when *fusiformis-runcinata* is comparatively rare, while the latter species comes on by the millions in late July, the former being at this time a real rarity in the net hauls.

Must I look to environment or the constitution of the creatures, or to both for answers? The very fact that I ask the questions almost compels me to look to both. If I knew for a *certainty* that the full answer lay in either direction alone, I should quite surely know the answer *itself,* so should be under no necessity of asking the questions. Well then, if my questions are serious and I have gumption enough to seek the answers where obviously they must be sought, it will be necessary to go at the constitution of the animals more searchingly than before, and also at the environment. In other words, I have run with full force into the problem of *organic adaptation.* There is no doubt in my mind that much, if not the whole, of the species problem, so overshadowing in the biology of the last hundred or more years, has been befogged by the generality of idea and want of methodological accuracy with which this very subject of adaptation has been treated. Pinned down to something really tangible and definite, does not the question formulate itself in this way: *In how far can the differentials between two kinds of organism be correlated with differentials in the environments which they respectively oc-*

cupy? Whether this formulary covers the whole case or not, it certainly reaches a good deal of it.

Immediately we see the problem take this form and resolve to tackle it on this basis we notice it to be in unison with at least two of the master principles underlying the soundest of progress in all physical science, viz., the principles of refined *quantitative treatment* and of *relativity*. I can make no real headway toward correlating kind-differentials among organisms with environmental-differentials without some measure of quantitative accuracy as to these differentials on both sides. If, for example, I find that *S. fusiformis-runcinata* flourishes equally well from the surface down to 350 fathoms while *S. democratica-mucronata* is never found deeper than say 50 fathoms, and if I am bent on finding out what there is, if anything, in the difference between the two animals that corresponds to the difference between 50 and 350 fathoms, I must bring these two sets of differences into an equation practically. This means that in order to give such a form of expression the real force of the mathematical equation, *i. e.,* to know that a known variable on one side must have a corresponding variable on the other, much, as a rule very much, quantitatively accurate data on each side will be necessary. And this means that a vast amount of observing, of comparing, and of measuring the animals themselves must be done. Thus much belongs to my province as a special student of these animals. For the physical data on the other side I am metaphorically as well as literally "all at sea." Do the kinds of organisms undergo their changes, reproductive, distributional, etc., which differ relatively to each other, within practically the same water, or is there different water corresponding to these changes? This calls first of all for knowledge of currents, which knowledge it is the business of a hydrographer to furnish. My own unaided attempts to get it would surely be wanting in reliability and furthermore would be made at the expense of time and energy that ought to be more profitably applied to tasks for which I am fitted.

Again, facts relative to the temperature, density and chemical composition of the water must surely enter into the environmental side of the equation. Who but a professional physicist and a professional chemist is fit to supply the data? The food of these species must be determined and at least some facts pertaining thereto must enter into the reckoning. No one but a specialist, perhaps several of them, on the groups of minute organisms which happen to constitute the dietary of salpa can furnish these data.

The long and short of all this is that it is impossible for me to handle the problems of species, distribution and adaptation of salpa with any large measure of success unless I can have the cooperation, not haphazard and incidental, but designed and sure, of specialists in several branches of science.

The object of this brief paper is to show something of what the present year means in the way of executing such a program at the San Diego Station.

The *Alexander Agassiz* is now ready to do any sort of at-sea work that the present main section of the program (planktology) calls for within the bounds of the area set off for investigation, *i. e.,* the area comprising the continental shelf from Point Conception southward to—Panama if necessary. The area in which most of our operations lie is about 15,000 square miles in extent and has a maximum depth of a little more than 1,000 fathoms.

I mention only one important point the craft has made during the summer concerning water-movements. By anchoring

on Cortez Bank about 95 miles off the coast, she has proved the existence of a northeast drift at this point for at least a portion of the year which is independent of tidal action. Published charts of the East Pacific and reports of navigators are conflicting as to such a drift. The prevailing view is, it seems, that it does not occur. The fundamental importance of reliable information on the question for problems of distribution of marine organisms in this locality hardly needs pointing out. How constant and extensive this drift is remains for future determination.

Thanks to the ingenuity of Professor C. A. Kofoid as a designer and to the skill of Messrs. Hensley and Baker, of San Diego, as mechanicians, a closing net is now in operation on the *Agassiz* that can be opened, towed and then closed at the same level, and at any depth in which the vessel can trawl. As a consequence I now have an abundance of *S. fusiformis-runcinata* that I know with certainty came from within a few feet of 350 fathoms, and likewise from various other intermediate depths. The mental comfort there is in the possession of information on this point about which there are no haunting doubts, is great and grows larger as one perceives the larger problems that hinge upon the trustworthiness of the data.

I may mention incidentally that the expenditures involved in this work at sea is not great relatively. What I mean by relatively is that the expense is small as compared with what such work costs when it is done in *coastal areas* by a vessel built and equipped for truly *oceanic areas and depths*. To illustrate: During March, 1904, through the good auspices of President D. S. Jordan it was my pleasure to have scientific direction of the United States Bureau of Fisheries Steamer *Albatross* for explorations on the coast of southern California. Excepting for about half a dozen trawl hauls made just beyond the edge of the continental shelf in 2,000 fathoms and over, the work of that period was in the same area and of the same general character as that now being done by the *Agassiz*. In almost all respects the advantages are surely with the *Agassiz*. The smaller vessel can be handled much more rapidly and surely, and can, of course, work in much shoaler waters, and has various other minor advantages that need not now be dwelt upon. Were the *Albatross* and the *Agassiz* both at the Station's command and both operable at the same expense I am quite sure we should use the *Albatross within our area* only on rare occasions. When work in specially rough waters became urgent we should want the larger vessel. It is only when depths beyond the continental shelf are to be explored that the large ship is needed, is in fact indispensable. Yet the *Agassiz* with her equipment represents an initial expenditure of less than $15,000 with a cost of operating amounting to about $22 per day (when a mooring can be made overnight), while the *Albatross* represents an initial expenditure of not less than $150,000 and a daily cost for operating of not less than $300.

This year, for the first time, a physicist has joined the staff as a regular member. Such equipment is supplied as is requisite for the investigations so far comprehended in the program. Mr. F. W. McEwen, an instructor in physics at the Leland Stanford Junior University, is the man in the place. About 400 density determinations have been made during June and July, reaching through depths to 400 fathoms. Naturally many more temperatures have been taken. The particular satisfaction in having a physical laboratory operating in conjunction with the biological work lies in the fact that whenever a special biological question comes along requiring informa-

tion from the physical side, the physicist can be appealed to *then and there*. That enables one to know what data either different or more of the same or relevant sort are to be sought. This is an advantage quite apart from that of having on hand a general stock, so to speak, of information about the water such as the systematic work of the physicist puts into the records.

As yet the station funds have not made possible a chemist and a chemical laboratory, but the addition of these in the not distant future is anticipated.

I may conclude by mentioning two other extensions of undertaking that stand to the credit of the present year. Miss Myrtle Johnson, of the station staff and a university student, has carried well forward a mensuration-mathematical study of growth and development of the zooids of the salpa chain. In this work Dr. J. Lipke, of the department of mathematics of the University of California, and Dr. Raymond Pearl, of Orono, Maine, have as a courtesy, rendered service without which the value of whatever results may be reached would be uncertain. Mr. S. E. Bailey, of the staff, has proven during the summer the practicability of determining with accuracy reaching to the fourth decimal place the weight of *Fundulus* eggs and embryos at various stages of development. The biological importance of investigations of this sort can not, I believe, be overestimated. This is no place to set forth the grounds of such belief although I may call attention to their obvious adjacency to such work as Minot in particular, has been doing recently on the weight of different animals at different periods of life.

Although the object of this communication is to indicate those aspects of the year's work that constitute a forward step in carrying out the general program of the Station, mention should be made of the fact that tasks under way for several years have by no means been neglected. Dr. Torrey made good progress in the description of the pelagic coelenterata; Mr. E. L. Michael, resident naturalist of the Station, has nearly completed a paper on the classification of the Chaetognaths of the region, and the director did something on the systematic treatment of the littoral ascidian fauna. Mr. Maurice Nichols, of the department of botany of the University of California, devoted much labor to the description of the corallanes. The usual work was continued of preserving and recording all collections brought in, preparatory to making them available for the various specialists who will report on them.

WM. E. RITTER

LA JOLLA, CAL.,
July 25, 1908

THE NATIONAL EDUCATION ASSOCIATION, IN CONVENTION ASSEMBLED AT CLEVELAND, O., JULY 1, 1908, DECLARATION

THE National Education Association, now holding its forty-sixth annual convention in Cleveland, and representing teachers and friends of education in every state in this union, makes the following declaration of principles and aims:

1. Fully realizing that trained and skilled labor is a primary essential to the industrial and commercial welfare of the country, we cordially endorse the establishment by municipal boards of education of trade schools, industrial schools, and evening continuation schools; and further recommend that the instruction in these schools be practical and efficient, and have the advice and the approval of the trade interested, to the end that graduates of these schools may at once become advanced apprentices or journeymen.

2. We recommend the subordination of highly diversified and overburdened courses of study in the grades to a thorough drill in essential subjects; and the sacrifice of quantity to an improvement in the quality of instruction. The complaints of business men